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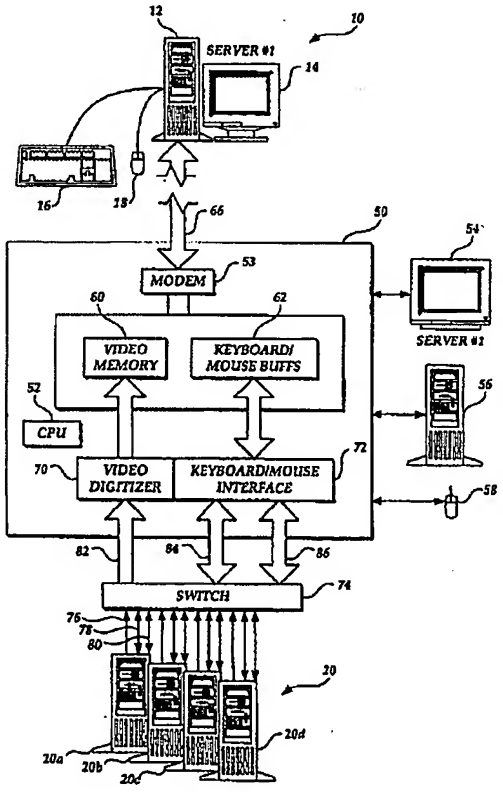
(54) Title: REMOTE COMPUTER CONTROL SYSTEM

(57) Abstract

A computer control system that allows a user of a remotely located workstation to control a target computer. A host computer runs a remote control program that transmits data in its video memory, and keyboard and mouse buffers to the remote workstation. The video signals of the target computer are digitized and stored in the host computer's video memory. In addition, keyboard and mouse signals to and from the target computer are stored in the host computer's keyboard and mouse buffers. The host computer then transmits these signals using the remote control program to the remotely located workstation.



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REMOTE COMPUTER CONTROL SYSTEM

Field of the Invention

The present invention relates to computer systems in general, and in particular to systems for accessing and controlling remotely located computers.

Background of the Invention

In most office or manufacturing environments, it is common to find a number of computer systems connected together by a local area or wide area network. In general, these networks include one or more server computers that control the network and provide additional services, such as storing commonly used programs, controlling network resources, and connecting the network to other wide area networks such as the Internet etc.

In the event that a problem occurs with a computer network, a system administrator may need to reboot or otherwise adjust the operation of one or more of the controlling server computers. Because the network is malfunctioning, it is generally not possible to access the server computers over the network and therefore the administrator must be physically present at the console of the server computer.

Most server computers are located in specially equipped rooms that are often heavily air conditioned and otherwise not particularly suited for a human operator. As a result, systems have been developed that can allow an operator to control a computer from a remote location.

One example of such a system is the Switchback® product manufactured by Apex PC Solutions, Inc. of Woodinville, WA, the assignee of the present invention. With the Switchback product, a user can control the operation of the computer from a remote workstation of the type that includes a monitor, a keyboard, and a mouse.

Commands entered with the keyboard and mouse are transmitted over a dedicated communication link such as a twisted wire cable, that is connected to the computer system to be controlled. The computer system then acts as if the commands were entered using its own keyboard or mouse. In addition, analog video signals produced by the controlled computer are transmitted to the video monitor of the workstation so that the operator can view the same display that is produced at the remotely controlled computer. While the Switchback product works well for many applications, there is a limit to how far the video, keyboard, and mouse signals can be transmitted on the dedicated communication link without a loss of resolution.

An alternative approach to systems like the Switchback product is to use a computer program that allows a computer to be controlled from a remote location. For example, PCAnywhere™ produced by Symantec of Cuptertino, California allows a computer to be accessed and controlled from a remote location. However, to control a computer using a program such as PCAnywhere™, requires that the program be running on the controlled computer. This both slows the operation of the controlled computer as well as provides a potential source of malfunction.

Therefore, there is a need for an out-of-band system that can be used to access and control a remotely located computer that operates over long distances and does not slow or degrade the operation of the controlled computer.

Summary of the Invention

To solve the problems associated with prior art remote computer access and control systems, the present invention is a system for operating a target computer from a remotely located personal computer workstation. The workstation includes a keyboard and mouse with which commands can be entered for the target computer. In addition, the workstation includes a video monitor that displays video signals generated by the target computer.

To connect the remote workstation with the target computer, the invention includes a host computer disposed between the target computer and the workstation. The host computer receives the analog video signals produced by the target computer and digitizes them for storage in its video memory. In addition, keyboard or mouse signals generated by the target computer are stored in keyboard and mouse buffers within the host computer. The host computer operates a remote access and control computer program that transmits the contents of the video memory, and the keyboard and mouse buffers to the remotely located workstation via a communication link. The remote workstation runs a complementary remote access and control computer

program that enables it to transmit keyboard and mouse signals to the target computer via the host computer. The present invention, therefore, does not require that the target computer operate special software and can transmit the video, keyboard, and mouse signals over greater distances than were previously possible.

Brief Description of the Drawings

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a block diagram of a system for accessing and controlling a remotely located computer system according to the present invention;

FIGURE 2 is a block diagram of a video digitizer according to another aspect of the present invention;

FIGURE 3 illustrates a video memory of a host computer that stores digitized video signals prior to transmission to a remotely located workstation; and

FIGURE 4 illustrates a typical analog video signal received from a target computer.

Detailed Description of the Preferred Embodiment

As indicated above, the present invention is a system for accessing and controlling a computer from a remote workstation without requiring that the accessed computer run a special computer program. The system transmits digitized video, keyboard, and mouse signals over a serial communication link to the remote workstation.

FIGURE 1 is a block diagram of the remote computer access and control system according to the present invention. Using the system, a user of a remote workstation 10 can access and control any of a number of target computers 20a, 20b, 20c, or 20d. Typically, the target computers are server computers that are connected to a computer network and operate to perform such tasks as controlling the operation of the network, storing commonly used programs or data, or connecting the network to the Internet, etc.

The remote personal computer type workstation generally comprises a central processing unit 12, including a communication device such as a modem (not shown), a monitor 14, a keyboard 16, and a pointing device such as a trackball, touch pad, or mouse 18. Commands or keystrokes entered using the keyboard 16 or mouse 18 operate to control the target computer as if the commands had been entered using a

keyboard and mouse that are connected directly to the target computer. In addition, the monitor 14 of the remote workstation displays the same video signals that are produced by the target computer 20.

To access and control the target computers 20, the present invention utilizes a host computer 50 that acts as an interface between a target computer and the remote workstation. The host computer 50 includes a central processing unit 52, a modem 53, a video monitor 54, a keyboard 56, and a pointing device such as a mouse 58.

The host computer 50 operates to fill a portion of a video memory 60 with the video signals produced by one of the target computers 20. In addition, the host computer fills a set of keyboard/mouse buffers 62 with keyboard and mouse commands to be sent to, or received from one of the target computers 20.

The host computer 50 includes a video digitizer 70 that receives the analog video signals produced by one of the target computers 20 and digitizes the signals for storage in a portion of the host computer's video memory 60. The host computer runs a remote access and control computer program that transmits the contents of the video memory over a communication link 66 to the remote workstation 10 so that the monitor 14 of the workstation will display the same video signals displayed by the target computer 20. In addition, the same video signals produced by the target computer 20 are also displayed on the monitor 54 of the host computer 50.

Keyboard and mouse control signals produced by the target computer 20 are transferred through a keyboard/mouse interface 72 within the host computer 50 for storage in the keyboard/mouse buffers 62. The buffers 62 include separate keyboard data and control buffers, as well as separate mouse data and control buffers. Keystrokes entered on the keyboard 16 of the remote workstation or on the keyboard 56 of the host computer 50 are stored in the keyboard data buffer. These keystrokes are then forwarded through the keyboard/mouse interface 72 to a keyboard connector on the target computer 20 in order to control the operation of the target computer. Signals from the mouse 18 or 58 are similarly stored in the mouse data buffers before being applied to a mouse connector on the target computer 20. In the other direction, keyboard control signals such as signals to light indicators on the keyboard are stored in the keyboard control buffer before being transmitted to the remote workstation, as well as the keyboard and mouse of the host computer.

To provide the ability of the remote workstation 10 to control multiple target computers, the present invention preferably includes a bi-directional switch 74 that is disposed between the host computer 50 and the target computers 20. Each of the target computers 20a, 20b, 20c, and 20d is connected to the switch 74 by three cables. A cable 76 is connected to the target computer's video out connector. A cable 78 connects to the target computer's keyboard connector and a cable 80 is connected to the target computer's PS/2 mouse connector. Connecting the switch 74 to the host computer 50 are an additional three cables. A cable 82 carries video signals from one of the target computers to a video digitizer 70 described in detail below. A cable 84 carries keyboard signals from the switch 74 to the keyboard/mouse interface 72 and a cable 86 carries the mouse signals between the switch 74 and the keyboard/mouse interface 72. With the switch 74, video signals produced by any of the target computers 20a, 20b, 20c, or 20d can be selected and the keyboard and mouse signals can be directed to any of the target computers. The switch 74 may comprise an Outlook™ switch produced by Apex PC Solutions, Inc. of Woodinville, Washington, the assignee of the present invention or other suitable computer switches.

To transmit the video, keyboard, and mouse signals to the remote workstation, the host computer 50 also runs a remote access and control computer program such as PCAnywhere™ to control the modem 53 that transmits the contents of a portion of a video memory 60 and the keyboard/mouse buffers 62 over the communication link 66 that connects the host computer 50 with the remote workstation 10. The communication link 66 may comprise a telephone line, a wireless communication link, or a global, wide area network such as the Internet. The remote workstation 10 also runs a remote access and control program in order to display the video signals on the monitor 14 and to transmit keystrokes and mouse signals back to the host computer 50 for forwarding to the target computer.

As indicated above, the switch 74 routes the analog video signals received from one of the target computers into the video digitizer 70. A block diagram of the video digitizer 100 is shown in FIGURE 2. To digitize the analog video signals, the vertical and horizontal synchronize signals must be detected. These signals may be supplied on separate leads, combined on a single lead, or may be encoded onto one of the red, green, or blue video signals depending upon the type of computer that is providing the analog video signals. The leads containing the horizontal and vertical synchronize signals are applied to a synchronize detect and separation circuit 102 that

detects these signals and converts them to the proper polarity. For example, some horizontal and vertical synchronize signals may be active low while others are active high. The synchronize detect and separation circuit 102 preferably converts the signals so that they are active high logic levels. A suitable synchronize detect and separation circuit 102 is part No. IN2100, produced by InLine, Inc., of La Habra, California.

The vertical synchronize signal is sent from the synchronize detect and separation circuit 102 to a microprocessor 104 that controls the operation of the digitizer. The horizontal synchronize signal is fed to an input of a counter 107 that counts the number of horizontal synchronize signals received. The microprocessor 104 signals the counter 107 each time a vertical synchronize signal is received so that the counter can begin counting. Upon the receipt of the next vertical synchronize signal, the counter informs the microprocessor how many lines are contained per frame of video data and restarts the count. The microprocessor uses this information to index a look up table to determine a range of "dot clock" values that define the rate at which the colors for each pixel in a row of video data are transmitted in the analog video signal. In addition, the microprocessor 104 determines the time between the falling edge of a vertical synchronize signal and the beginning or rising edge of a subsequent vertical synchronize signal. This time determines the vertical size of a frame of video data and is used to refine the dot clock estimation.

The horizontal synchronize signal detected by the synchronize detect and separation circuit 102 is also applied to an input of a phase lock loop circuit 106. The phase lock loop circuit compares the phase of the horizontal synchronize signal to the phase of a clock signal produced by a programmable divider 108. The output of the phase lock loop circuit 106 drives an input of a voltage controlled oscillator 110 to produce a clock signal having a frequency that is proportional to the output of the phase lock loop circuit 106. The clock signal produced by the voltage controlled oscillator 110 is supplied to an input of a programmable divider 112 that may reduce the frequency of the incoming clock signal by a programmable amount. Because the voltage controlled oscillator 110 has a limited frequency range, the programmable divider 112 increases the useful operating range of the clock signal produced to accommodate lower resolution video signals. When operating properly, the output of the programmable divider 112 has the same frequency or a multiple of the dot clock.

The initial settings for the programmable dividers 108 and 112 are set by the microprocessor based on the initial values of the dot clock frequency read from the look up tables. The output of the programmable divider 112 is fed to an input of the programmable divider 108 that feeds the input of the phase lock loop circuit 106 described above.

The output of the programmable divider 112 is also fed to an input of a gating counter 114 that is activated to pass the output signal produced by the programmable divider 112 during the active portion of the video signal. As will be appreciated by those skilled in the art, a video signal for a horizontal row of a video display comprises an active video portion and a blanking portion that occurs when the video signal retraces. In order to avoid sampling the video signal during the retrace period, the gating counter is programmed to pass the clock signal produced by the programmable divider 112 only during the active video portion of the video signal.

During the active video portion of the video signal, the clock signal produced by the programmable divider 112 is passed by the gating counter 114 to an input of a phase adjust circuit 116. The phase adjust circuit is set so that the active video portion of the video signal is sampled at the center of each pixel value. If the pixel is not sampled at the center, the resulting video image can appear blurry or shadowed. Therefore, the phase adjust circuit changes slightly the phase of the incoming clock signal based on signals received by a user of the remote workstation who may press one key to advance the sampling time and another key to retard the sampling time until the display looks the best. Alternatively, the phase adjust circuit may be controlled by the microprocessor 104.

The output of the phase adjust circuit 116 clocks an analog to digital converter 118 to sample a video signal. The red, green, and blue analog video signals received from a target computer are supplied to a sequencer 120 that operates as a three-way switch. The sequencer selects one of the video signals to be sampled by the analog to digital converter 118. Each time the digitizer is clocked, a sample of the video signal is recorded for storage in the host computer's video memory. After an entire frame of video signals has been sampled, the sequencer 120 selects another of the red, green, or blue video signals in a rotating fashion. It is also possible to sample all three video signals simultaneously with the addition of two further analog to digital converters.

The output of the analog to digital converter 118 feeds a digital signal processor 122 that determines whether the analog to digital converter 118 is sampling

the active portion of video signals at the correct time. If not, the DSP can instruct the phase adjust circuit 116 to adjust the phase of the sampling clock. The digital signal processor analyzes the received samples and instructs the microprocessor to adjust the timing or phase of the clocking signal until the minimum and maximum amplitudes of the incoming video signal are located.

The sample of the video signal produced by the analog to digital converter 118 is fed to a peripheral component interface (PCI) bus master chip 124. The bus master chip 124 writes the data on a PCI bus 126 that connects the video digitizer with the host computer's video memory 60. After storage in the video memory, the video data is transmitted to the remote workstation by the host computer.

FIGURE 3 illustrates a typical video signal to be sampled with the superimposed horizontal synchronize signal. Marking the beginning of a row of active video data is a horizontal synchronize signal 150. The time between successive horizontal synchronize signals defines the horizontal clock rate of the video display. The time between the beginning of a horizontal synchronize signal and the active portion of the video signal, shown as t_s, is defined by the resolution of the particular video display. Upon the detection of a horizontal synchronize signal, the gating counter 114 described above, times an interval equal to t_s before passing the clock signal produced by the programmable divider 112 to the phase adjust circuit 116.

The active portion of the video signal is sampled once for every pixel that comprises a row of the video display. The clocking signals produced by the programmable divider 112 have a period equal to the dot clock of the video display t_{dc}. The gating counter 114 counts the number of clocking signals received and prevents the clocking signals from reaching the phase adjuster 116 after the video signal has been sampled one time for each pixel in the display. The gating counter is programmed with the correct number of pixels in a display either by the microprocessor given the number of rows in a video frame as determined by the counter 107 described above or by allowing a user to select from a number of typical resolutions. Typical resolutions include 1024 X 768, 640 X 480, 800 X 600, etc.

At the end of the active portion of the video signal, the signal is blanked out during the video retrace. The length of the blanking period, shown as t_b, is also defined by the resolution of the video signal and the particular type of computer that generates the display. Once the next horizontal synchronize signal is obtained, the gating counter again allows the clocking signals to reach the phase adjuster 116, after timing an interval t_s.

FIGURE 4 illustrates how the digitized video signals are stored in the video memory of the host computer. The video memory 200 can be overwritten and read asynchronously. Therefore, the video digitizer can be writing values to the memory as the host computer is reading the memory and transmitting the digitized video signals to a remote workstation.

As indicated above, the present invention preferably fills the video memory by overwriting one color at a time. For example, the memory comprises a series of memory bytes 202 each containing values for the red, green, and blue pixel intensities. The red values of each pixel in a video frame are digitized and written into the memory followed by green pixel values for the next frame and blue pixel values for the subsequent frame. Because a video image does not change significantly from frame to frame, the effect of updating only one color at a time is not noticeable to the user.

As can be seen from the above, the present invention allows a remote computer to access a target computer without requiring that the target computer run its own remote control program. Using a single host computer and two copies of a remote access and control computer program, a remote workstation is able to control multiple target computers. The present invention therefore allows network administrators or other support personnel to access server computers from a remote location over a variety of serial data communication links.

While the preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention. It is therefore intended that the scope of the invention be determined from the following claims and their equivalents.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A system for controlling a target computer from a remote workstation of the type that includes a keyboard, a mouse, and a monitor, comprising:

a host computer including a video memory and keyboard/mouse buffers that store signals from a keyboard and a mouse;

a video digitizer coupled to the host computer that receives analog video signals from the target computer, samples the video signals, and stores the video signals in the video memory;

a keyboard/mouse interface that receives keyboard and mouse signals from the target computer and stores them in the keyboard/mouse buffers; and

the host computer operating a remote access and control program that transmits the contents of the video memory and the keyboard/mouse buffers to the remote workstation over a communication link.

2. The system of Claim 1, wherein the host computer receives keyboard and mouse signals from the remote workstation, stores the received keyboard and mouse signals in the buffers and forwards the contents of the keyboard/mouse buffers to a keyboard and mouse input on the target computer.

3. The system of Claim 1, further comprising a switch disposed between the host computer and one or more target computers.

4. The system of Claim 1, wherein the communication link is a telephone line.

5. The system of Claim 1, wherein the communication link is a wireless link.

6. The system of Claim 1, wherein the communication link is a computer network.

7. The system of Claim 1, wherein the video digitizer includes a phase lock loop that produces a clocking signal having a frequency substantially equal to the time at which pixel values are transmitted in the video signal and a gating counter that

passes the clocking signal to an analog to digital converter that samples the video signal during an active video portion of the video signal.

8. The system of Claim 1, wherein the video digitizer alternately samples a single color video signal in a frame of video data and stores the samples in the video memory.

9. A video digitizer for receiving analog video signals at a plurality of resolutions and for storing the video signals in a video memory of a host computer comprising:

a synchronize detect circuit that detects vertical and horizontal synchronize signals from an analog video signal;

a microprocessor that determines a clocking rate at which the analog video signal should be sampled from the timing of the vertical and horizontal synchronize signals;

a clock signal generator that produces a clock signal at the clocking rate;

an analog to digital converter that is controlled by the clock signal to sample the analog video signal; and

a bus interface circuit that writes the samples of the analog video signal into the video memory of the host computer.

10. The video digitizer of Claim 9, wherein the clock signal generator comprises:

a phase lock loop circuit that compares the phase of the horizontal synchronize signal with the phase of a divided clocking signal;

a variable oscillator that produces the clocking signal that controls the analog to digital converter, wherein the clocking signal has a frequency that is dependent on the difference in phase between the horizontal synchronize signal and the divided clocking signal; and

a programmable divider that receives the clocking signal produced by the variable oscillator and produces the divided clocking signal that is fed to the phase lock loop circuit.

11. The video digitizer of Claim 10, further comprising a gating circuit that receives the clocking signal and passes the clocking signal to the analog to digital converter during an active video portion of the analog video signal.

12. The video digitizer of Claim 10, further comprising a phase adjust circuit that adjusts the phase of the clocking signal.

13. The video digitizer of Claim 9, further comprising a selection circuit that alternately selects a red, green, and blue component on the analog video signal to be sampled by the analog to digital converter.

14. The video digitizer of Claim 9, wherein the analog to digital converter includes separate analog to digital converters to sample the red, green, and blue components of the analog video signal.

15. The video digitizer of Claim 9, wherein the host computer operates a remote access and control program that transmits the contents of the video memory to a remote computer system.

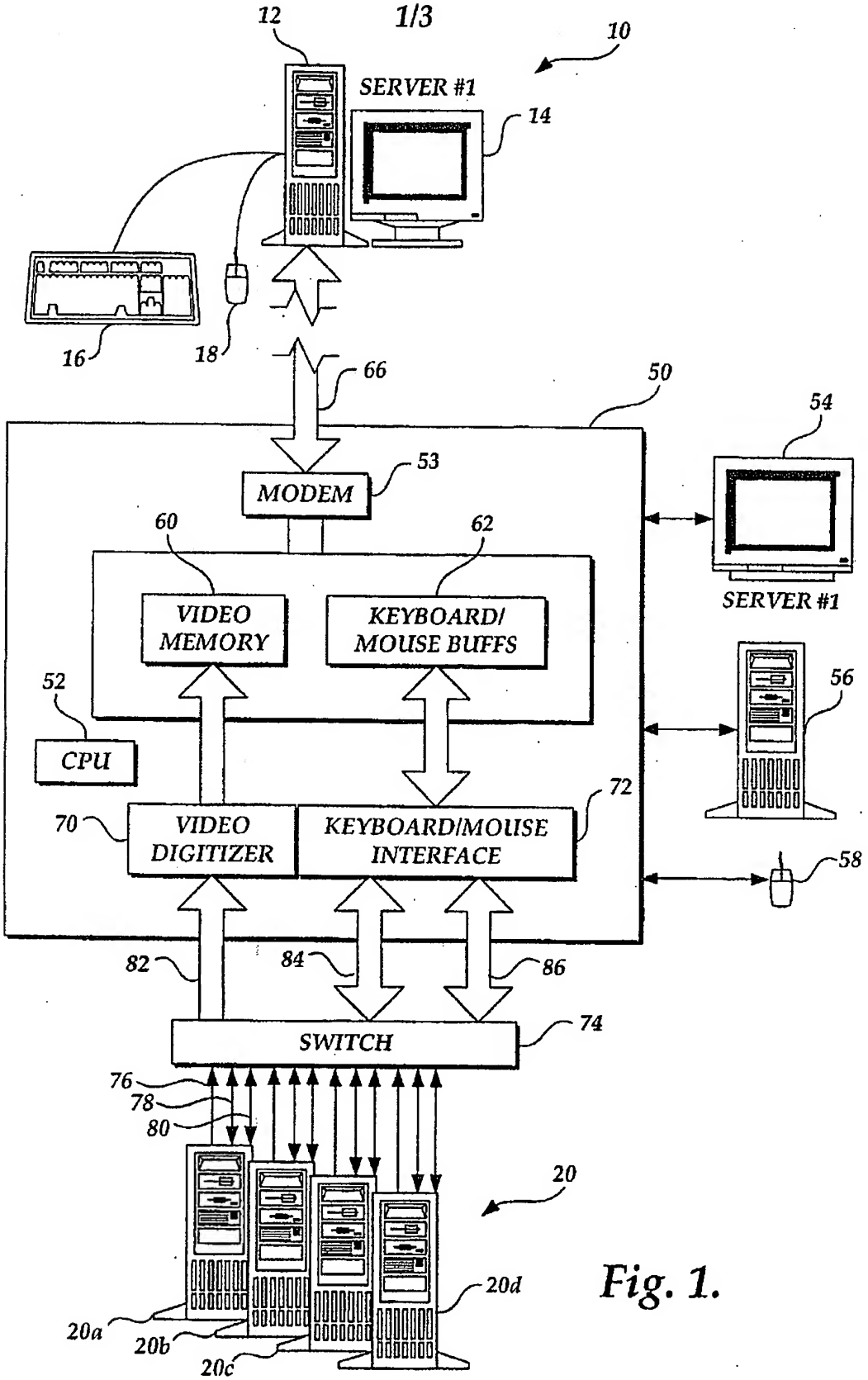
16. A system for controlling a target computer from a host computer comprising:

a video digitizer that receives analog video signals from the target computer and stores the video signals in a video memory within the host computer for display on a monitor coupled to the host computer;

a set of keyboard and mouse buffers that store keyboard and mouse control signals from the target computer as well as keyboard and mouse data signals that are received from a keyboard and mouse coupled to the host computer; and

wherein the host computer transmits the contents of the set of keyboard and mouse buffers to the target computer in order to control the operation of the target computer.

17. The system of Claim 16, wherein the host computer further comprises a communication device that transmits the contents of the video memory and the keyboard and mouse buffers to a remotely located computer and receives keyboard and mouse data signals from the remotely located computer for storage in the set of keyboard and mouse buffers so that the target computer can be controlled from the remotely located computer.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CPU
72
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VIDEO DIGITIZER
KEYBOARD/MOUSE INTERFACE
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74
76
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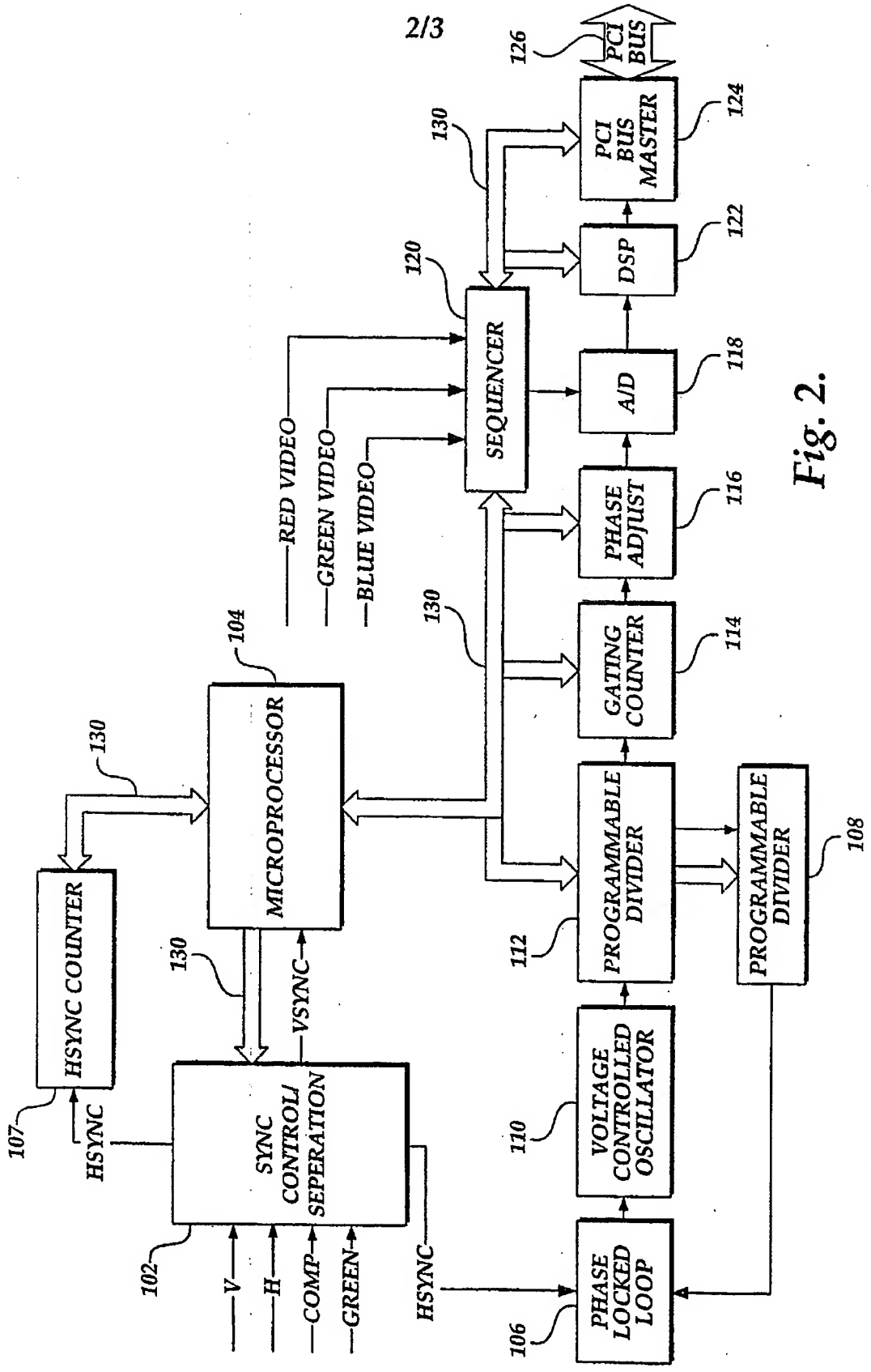
80
20
20d
20a
20b
20c

Fig. 1.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108
VOLTAGE CONTROLLED OSCILLATOR
110
PHASE LOCKED LOOP
106
SEQUENCER
120
130
MICROPROCESSOR
104
HSYNC COUNTER
107
SYNC CONTROL/ SEPERATION
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VSYNC
V
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COMP
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RED VIDEO
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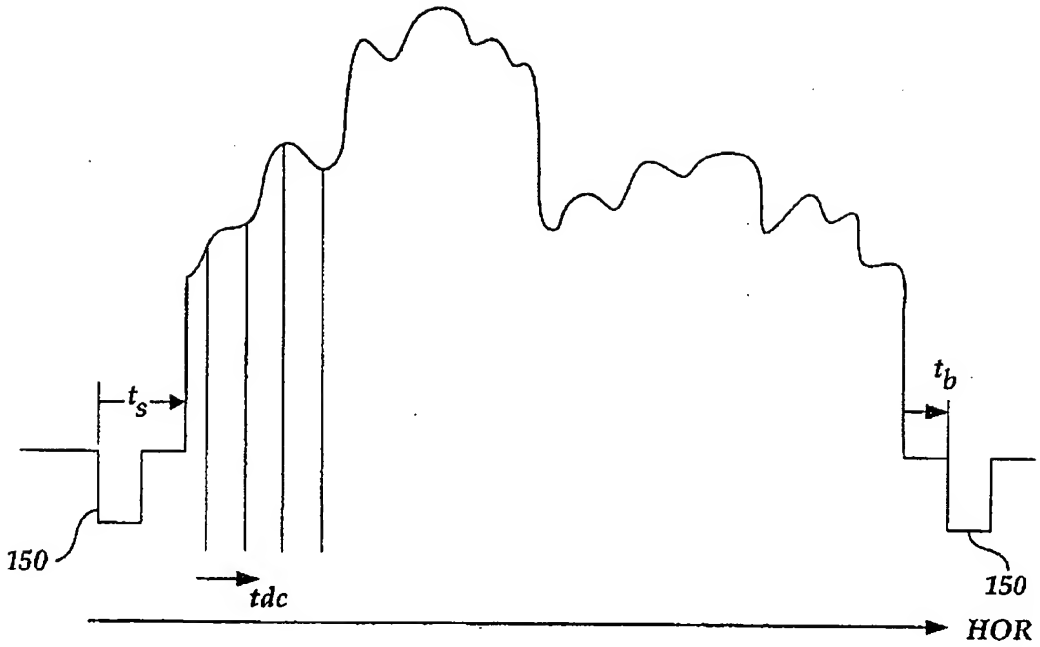
BLUE VIDEO

Fig. 2.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t_b
150
150
tdc
HOR

Fig. 3.

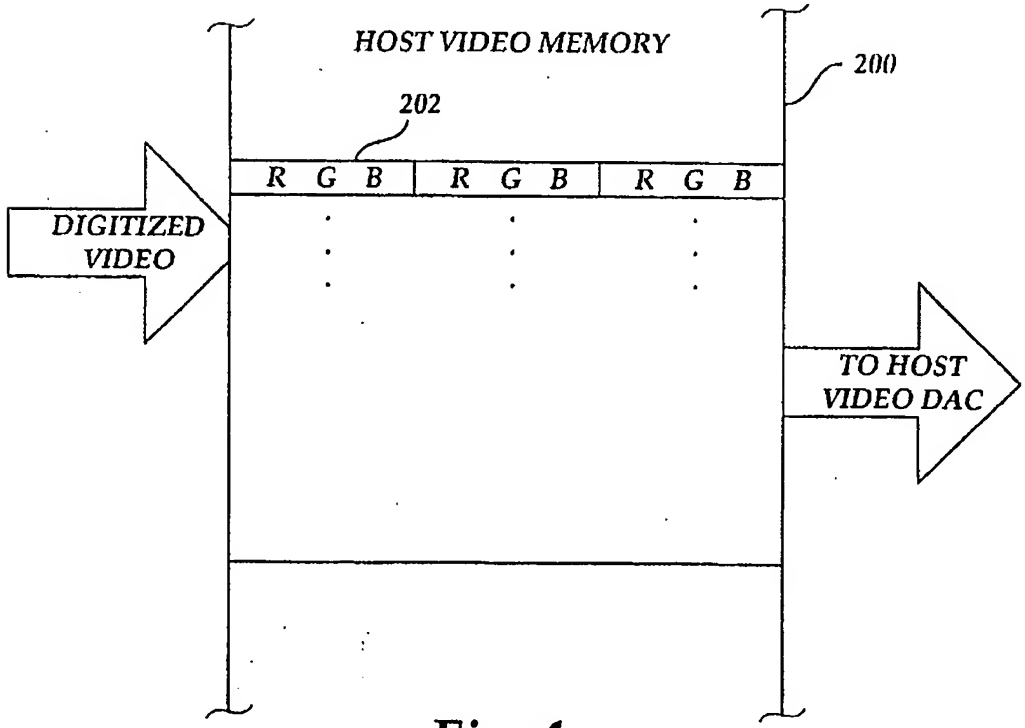
HOST VIDEO MEMORY
200
202
R G B R G B R G B
DIGITIZED VIDEO
TO HOST VIDEO DAC

Fig. 4.

INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/US 98/16678

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G06F3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95 19595 A (FOX NETWORK SYSTEMS INC) 20 July 1995 see abstract; figures 1-4 see page 6, line 18 - page 11, line 29	1-4,16, 17
A	EP 0 520 768 A (COMPAQ COMPUTER CORP) 30 December 1992 see abstract; figure 1	1
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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30 November 1998	07/12/1998

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INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
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